test # 7

26/26 100%

1. a. H_2SO_4
   b. NO_3^-
   c. HCO_3^-
   d. OH^-

2. $\underbrace{CH_3CH_2COOH}_{\text{Acid}} + \underbrace{(CH_3)_3N}_{\text{Base}} \rightleftharpoons \underbrace{(CH_3)_3NH^+}_{\text{conjugate Acid}} + \underbrace{CH_3CH_2COO^-}_{\text{conjugate Base}}$

3. The strong acids are c and g
   The strong bases are f and b

4. The difference between the Lewis and Brønstead-Lowry definition of acids is that the Lewis definition says lone pairs of electrons are accepted whereas in the Brønsted-Lowry definition, H^+ are accepted

5. Yes, it is possible for a Lewis acid to also be a Brønstead-Lowry

6. F^- is the base and BeF_2 is the Acid

7. pH of 0.040 M solution of HNO_3? $HNO_3 + H_2O \rightarrow H_3O^+ + NO_3^-$

$$\left(\frac{0.40 \text{ moles of } HNO_3}{1 \text{ liter}}\right)\left(\frac{1 \text{ mole of } H_3O^+}{1 \text{ mole of } HNO_3}\right) = \frac{0.040 \text{ moles of } H_3O^+}{1 \text{ liter}}$$

$= 0.040 \text{ M } H_3O^+$

$pH = -\log(H_3O^+) = -\log(0.040) = \boxed{1.40}$

8. pH of 0.12 M of KOH?

$KOH(s) \rightarrow K^+(aq) + OH^-(aq)$

$$\left(\frac{0.12 \text{ moles of KOH}}{1 \text{ liter}}\right)\left(\frac{1 \text{ mole of } OH^-}{1 \text{ mole of KOH}}\right) = \frac{0.12 \text{ moles of } OH^-}{1 \text{ liter}} = 0.12\,M\ OH^-$$

$$\frac{(H_3O^+)(0.12)}{0.12} = \frac{1\times10^{-14}M^2}{0.12}$$

$= 8.3\times10^{-14}\,M$

$\rightarrow pH = -\log(8.3\times10^{-14}M)$

$pH = \boxed{13.08}$

9. pH of 2.4 M of H_2CO_3? K_a of $H_2CO_3 = 4.3\times10^{-7}$
K_a of $HCO_3^- = 7\times10^{-11}$

$H_2CO_3 + H_2O \rightleftharpoons H_3O^+ + HCO_3^-$

$$K_a = \frac{(H_3O^+)(HCO_3^-)}{(H_2CO_3)}$$

$$4.3\times10^{-7} = \frac{(x)(x)}{2.4} \Rightarrow 2.4 \cdot 4.3\times10^{-7} = \frac{x^2}{\cancel{2.4}} \cdot \cancel{2.4}$$

$\sqrt{x^2} = \sqrt{1.032\times10^{-6}}$

$x = 1.015874\times10^{-3} = 0.0010$

$pH = -\log(H_3O^+)$

$= -\log(0.0010) = \boxed{3.00}$

10. $HI + HCO_3^- \rightarrow H_2CO_3 + I^-$

11. Ka of $H_2PO_4^- = 6.3 \times 10^{-8}$
Ka of $H_2CO_3 = 4.3 \times 10^{-7}$

Compare strength

$Ka \cdot Kb = Kw$

stronger

$$\frac{(6.3\times10^{-8})Kb}{6.3\times10^{-8}} = \frac{1\times10^{-14}}{6.3\times10^{-8}} \quad \boxed{Kb = 1.6\times10^{-7}}$$

$$\frac{(\cancel{4.3\times10^{-7}})Kb}{\cancel{4.3\times10^{-7}}} = \frac{1\times10^{-14}}{4.3\times10^{-7}} \quad Kb = 2.3\times10^{-8}$$

$$\boxed{HCO_3^- + HPO_4^{2-} \rightleftharpoons CO_3^{2-} + H_2PO_4^-}$$

12. Ka of $HSO_4^- = 0.012$

$H_2SO_4 + KOH \rightarrow H_2O + K^+ + HSO_4^-$ ✓

Reaction: $H_2SO_4(aq) + H_2O(l) \rightarrow H_3O^+(aq) + HSO_4^-(aq)$ ✓

$$\left(\frac{0.25 \text{ moles of } H_2SO_4}{1 \text{ liter}}\right)\left(\frac{1 \text{ mole of } H_3O^+}{1 \text{ mole of } H_2SO_4}\right) = \frac{0.25 \text{ moles of } H_3O^+}{1 \text{ liter}}$$

$= 0.25\,M\ H_3O^+$

New Reaction: $HSO_4^-(aq) + H_2O \rightleftharpoons H_3O^+(aq) + SO_4^{2-}(aq)$

$$Ka = \frac{(H_3O^+)(SO_4^{2-})}{(HSO_4^-)} \Rightarrow 0.012 = \frac{(0.25+x)(x)}{(1.25-x)}$$ ✓

$$0.012 = \frac{x^2 + 0.25x}{(1.25 - x)} \cdot (1.25 - x)$$

$(1.25 - x)$

$$(1.25 - x)(0.012) = x^2 + 0.25x$$

$$0.015 - 0.012x = x^2 + 0.25x$$

$$-0.015 \quad +0.012x \qquad +0.012x - 0.015$$

$$0 = x^2 + 0.26x - 0.015$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-0.26 \pm \sqrt{(0.26)^2 - 4(1)(-0.015)}}{2}$$

$$= \frac{-0.26 \pm \sqrt{0.0676 + 0.06}}{2} = \frac{-0.26 \pm \sqrt{0.1276}}{2}$$

$$= 0.050 \text{ or } -0.31$$

$$pH = -\log(H_3O^+) = -\log(0.30M) = \boxed{0.52}$$

13. $H_2SO_4 + KOH \rightarrow H_2O + K^+ + HSO_4^-$

Reaction: $HSO_4^- + KOH \rightarrow H_2O + K^+ + SO_4^{2-}$

New Reaction: $HSO_4^-(aq) + H_2O(l) \leftrightharpoons H_3O^+(aq) + SO_4^{2-}(aq)$

$$K_a = \frac{(H_3O^+)(SO_4^{2-})}{(HSO_4^-)_{1.00 - x}} \Rightarrow 0.012 = \frac{x(0.25 + x)}{(1.00 - x)} \cdot (1.00 - x)$$

$$0.012(1.00 - x) = x^2 + 0.25x$$

$$0.012 - 0.012x = x^2 + 0.25x$$

$$-0.012 \quad +0.012x \qquad +0.012x - 0.012$$

$$0 = x^2 + 0.26x - 0.012$$

$$x = \frac{-0.26 \pm \sqrt{0.0676 - 4(1)(-0.012)}}{2} = \frac{-0.26 \pm \sqrt{0.1156}}{2}$$

$$= \frac{-0.26 \pm 0.34}{2} = 0.04 \text{ or } -0.30$$

$$pH = -\log(0.04M) = \boxed{1.4}$$